Changes in the Economic Result of Quarries

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Abstract

The article deals with the analysis of changes of 6 quarries economic results in the period 2013– 2018, that was an improvement and deterioration of the economic results. The analysis shows that changes in the economic results are mainly influenced by changes in sales and variable cost management.

Keywords: *quarrying, financial results of quarries, change of financial results*

Introduction

The collection of natural materials on the surface of the earth and later surface mining has accompanied human society since ancient times. Over time, mining and processing technology has improved, but the essence of quarrying has remained fundamentally the same. The original exchange in kind was replaced by trading on the principles of economy. Quarrying activities contribute to the economic development and employment, support communities in the provision of social amenities and infrastructure among others (Panagopoulos et al.; 2017; Baah- Ennumh et al.; 2021). The outbreak of COVID-19 virus has triggered a global public health crisis. Restricting the movement of people has resulted in a substantial contraction in economic activity. It was connected with production shock (many businesses have been temporarily shut down) and consumption shock (consumers reduced their discretionary spending and increased their precautionary savings (de Bruin et al.; 2020).

The reduction in demand and investment activity affected the economic results of companies, including quarrying. The profit of the quarries has decreased. In many cases, it turned into a loss. The situation during the pandemic was not exceptional. The global financial crisis in the period 2008-2009 had similar effects.

The question then arises as to whether fluctuations in the economic result are only linked to a drop in demand and production or whether there are other influences as well. This problem is also relevant for large mining companies owning many quarries. Identical raw materials are extracted in these quarries, the technological essence of the mining process is comparable, safety regulations require the same qualification of employees at all quarries. Nevertheless, the economic results measured by the profit/loss of a particular quarry are quite different. Therefore, the questions can be formulated in general: (i) why some quarries are profitable and some unprofitable (ii) why their economic results change.

Answers to these questions were sought in the conditions of a major company operating a lot of quarries in Central and Eastern Europe. Attention was paid to quarries in the Czech and Slovak Republics.

Quarrying and its effects

Quarrying is the process of extracting minerals and rocks from natural deposits located on or below the Earth's surface and processing them into commercial products. Commercial products are crushed aggregate, sand, gravel, energy raw materials (e. g. coal) and industrial minerals (gypsum, kaolin, clay, etc.).

Although the growth of the aggregates industry will positively and materially impact jobs, earnings, and sales in many sectors of the national´s economy (Ford and Spiwak; 2017), quarrying industry has many negative consequences--change of geomorphology and conversion of land use, with the associated change in visual scene. This major impact may be accompanied by loss of habitat, noise, dust, vibrations, chemical spills, erosion, sedimentation, and dereliction of the mined site (Langer; 2001; Milgrom; 2008; Willis and Garrod; 1999). Quarrying represents competition for the use of land, for example for agriculture or infrastructure construction in the region. It is therefore not surprising that quarrying of minerals is met with public opposition. Quarries remain one of the most disliked forms of development behind casinos, power plants and landfill sites (Quarry Management; 2008). Public perception of mining and quarrying is generally very poor (Bloodworth et al.; 2009), although there are some exceptions (Panagopoulos et al.; 2017).

Establishing new mining capacity becomes extremely difficult, at best, quarries are pushed further from populated areas. Aggregates are, however, characterized by a low unit value. When the transport distances from the place of extraction to the place of consumption are extended, the transport costs have a high proportion in the total unit costs. As a result, most of the demand for aggregates is met by local producers from shorter distances, which vary from country to country but remain the same order of magnitude: 40 kilometres (Menega-

ki and Kalimpakos, 2010; Highley et al. in Bloodworth et al. 2009), 30 miles (approx. 48 km) (Jaeger, 2006), 50 km (Escavy et al., 2020), 56 km (Escavy et alt., 2022), 80 km (Poulin and Bilodeau, 1993). It means that suitable geological conditions are a necessary, but not sufficient, condition for a viable quarry. What does a favourable economic outcome of a quarry depend on?

The economic result of quarrying

The economic result of any company, including a quarry, is, in its simplest form, the difference between total revenues and total costs. It takes the form of profit or loss. In the short term, a firm can lose money and still operate by drawing from previously accumulated financial reserves. But in the long term, securing profit is essential for the survival of the company. (Hill, 2017).

Publications related to the economics of individual quarries are mostly associated with the evaluation of investments, changes in quarry operations or optimization of quarry operations (e. g. Fiore et al.; 1970, Şirin et al.; 2021, Altus Group; 2021).

Analyses of the economic results of quarries receive little attention in publications, although "...quarrying is a "run for profit business" (Milgrom; 2008). The major reason anyone would go into quarry operation is to make profit by recovering as much valuable (quality) materials from the deposit as possible at an economical level (Igonor and Oden; 2011).

The analysis of the economic results of the quarries was carried out in the conditions of a company based in the Czech Republic. The company is part of a multinational concern containing companies in the form of joint-stock companies and limited liability companies, which are interconnected by property. Individual companies include quarries located in Central and Eastern European countries. The initial information was production statistics and accounting of individual quarries. Due to the confidentiality of these data, the identification of the multinational concern or the analysed company is not given.

This company provides mining, production, and sale of aggregates for concrete and asphalt mixtures, road and engineering constructions, railway construction, regulation of water flows. Quarries are characterized by seasonal production. The winter period is mostly used for winter repairs of a larger scale. Repairs are financed from the reserve for winter repairs, which is formed during the mining period. Accounting is conducted in euros. Each location is reported as a separate unit, sales of its products and all operating costs are recorded. Costs that cannot be allocated to individual sites are transferred to the quarries through overheads. Overheads are calculated as a percentage of sales for aggregate sales to foreign customers.

All quarries report their information in the following structure:

- production of construction materials in tons (sand, gravel, quarry stone, other products).
- sales in tons
- sales for individual assortment items in euros
- other sales (transportation, rental of machines, etc.)
- total revenue
- change in stock level
- revenue from sales
- variable costs (drilling and blasting work, energy, repairs, subcontracts, variable wages, service etc.)
- contribution per unit
- fixed costs (depreciation, fixed wages, insurance, taxes, interest, etc.)
- economic result
- breakeven point in tons
- profitability of sales

Based on these production statistics and accounting data, the economic results of individual quarries can be analysed.

Two basic questions related to the economic results of quarries can be formulated as follows:

- What factors cause some quarries to be profitable and others to be unprofitable?
- What factors cause some quarries to improve their economic results year-over-year (change from loss to profit, reduce loss or increase profit) and other quarries to worsen their economic results year-to-year (change from profit to loss, reduce profit or deepen loss)?

It is obvious that only factors reported within the given company could be considered, i.e., primarily information from accounting and production statistics. Other company information sources were used for a small number of indicators.

The first question can be answered based on long-term operational experience (Zapletalová pers. comm.).

A profitable quarry can be characterized as follows: it is a large quarry with sufficient reserves of mineral raw material, with quality rock in terms of technological parameters and applicability. On this basis, the quarry achieves higher production prices, it is free from conflicts of interest that would limit its production. The quarry is not located close to the settlement, it has an available infrastructure. The technological line to produce crushed aggregate is stable and uses electrical energy. The quarry is characterized by higher extraction and sales of production. In many cases, large-scale constructions stabilizing the supply of mined raw materials for a longer period are in the relative vicinity. The quarry is associated with a cheaper acquisition in the more distant past.

Loss quarry is relatively small with smaller production and lower selling prices. The technological line is mobile, the energy source is diesel, the line is usually older. The quarry is located closer to settlements, which limits the scope of blasting work and the quantity of production transported through the village. The entire range is not produced, sales are directed to shorter distances. There are no nearby large-scale structures. The effect of insufficient production is a high proportion of fixed costs per unit of production.

The answer to the second question was sought based on detailed analysis of statistical and accounting data.

Factors causing improvement or deterioration of economic results of quarries

The analysis was carried out in the conditions of the mentioned company at 6 quarries in the period from 2013 to 2018. For each quarry, the economic result has therefore changed 5 times between individual years. Out of 30 changes, there was an improvement in the economic result 17 times, of which 6

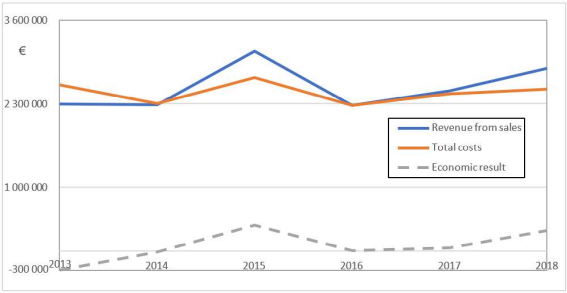

Fig. 1. Development of the economic result
Rys. 1. Rozwój wyniku ekonomicznego

times there was a transition from loss to profit. In 13 cases, there was a deterioration in the economic result, of which 2 times a transition from profit to loss.

An example of this development can be seen in Figure 1.

Based on accounting information and production statistics, an analysis of the origin and development of the economic result between individual years was performed. The analysis was carried out separately for deterioration and separately for improvement of the economic result. The research was conducted separately for the revenues and separately for the costs.

Revenues

Revenues depend on sales for aggregates (so-called net sales), according to individual types of assortments. Other sales are added to these sales – transport to the customer, space rental, machine rental, etc. This is how the total sales are obtained. Shipping costs are deducted from them and the change in inventory is added. This determines the revenue from sales.

In the structure of sales revenue, net sales have the largest share. These are determined by the total sales in tons, the sales structure (i. e. the assortment) and the prices of the individual items in the assortment. The influence of individual factors can be determined using the following procedure (Dvořáček; 1997): we start from the initial year (period (0)) and the subsequent year (period (1)). We will recalculate the sales structure of the period (1) with the prices of the period (0), i. e. we simulate a situation where there was no change in prices. Then we calculate the sales structure of period (0). According to this structure, we will divide the total amount of production of period (1). Thus, we assume that only the total quantity has changed, but its structure has remained. We multiply the calculated sales structure by the prices of the period (0). In this way, we simulate the situation that in period (1) the structure and prices in period (0) were preserved. If q_i denotes the sale in tons of individual assortment items, p_i denotes the prices of individual assortment items, and q_p the size of individual assortment items of the period (1) in the structure of the period (0), then it is possible to determine:

total change in net sales:	$\Sigma q_1p_1 - \Sigma q_0p_0$
in which:	
the effect of price changes:	$\Sigma q_1p_1 - \Sigma q_1p_0$
effect of the change in assortment:	$\Sigma q_1p_0 - \Sigma q_pp_0$
effect of quantity change:	$\Sigma q_1p_0 - \Sigma q_0p_0$

In doing so: $\Sigma q_p = \Sigma q_1$. We perform the total for all items in the assortment. In this way, it is possible to find out which factor has the greatest quantitative influence on the change in net sales.

The revenue analysis was performed separately for the deterioration of the economic result and separately for the improvement of the economic result.

Deterioration of the economic result: revenues

The deterioration of the economic result occurred in 13 cases. Of which:

- In 9 cases production decreased, in 4 cases production increased.
- In 11 cases aggregate stocks increased, in 2 cases stocks decreased (sales were greater than production).
- In 11 cases the sales revenue decreased, in 2 cases the sales revenue increased.

The change in sales for aggregates was most influenced by:

- the change in quantity that had the most negative effect (decrease in sales) in 9 cases;
- the change in assortment that had the most negative effect in 3 cases;
- the change in assortment that had the most positive effect in 1 case.

Improving the economic result: revenues

There was an improvement in the economic result in 17 cases. Of which:

- In 12 cases production increased, in 5 cases production decreased.
- In 10 cases aggregate stocks increased, in 7 cases stocks decreased (sales were greater than production).
- In 12 cases the sales revenue increased, in 5 cases the sales revenue decreased.

The change in sales for aggregates was most influenced by:

- the change in quantity that had the most positive effect in 12 cases;
- the change in quantity that had the most negative effect in 5 cases.

Sub-summary for the revenues: for a change in the economic result, it is not the change in production that is decisive, but in sales. Out of the total number of 16 cases of growth in production (with deterioration as well as improvement in the economic result), in 12 cases (75%) stocks also increased. Part

of the production therefore did not find a market. In 9 cases (64%) of the 14 cases of a decrease in production (with a deterioration as well as an improvement in the economic result), stocks also increased. A change in sales affects a change in sales revenue, and these are closely related to a change in economic results. Out of 13 cases of deterioration of the economic result, in 11 cases (85%) the sales revenue decreased. Out of 17 cases of improvement in the economic result, in 12 cases (71%) the sales revenue increased. The change in the amount sold had a dominant effect on the change in aggregate sales.

Costs

Based on operational experience, the issue of natural conditions, technology and quarry management can be projected into the costs (Zapletalová, pers. comm.). Since the quarries have different sizes and different levels of production, we used indicators determined as the ratio of costs to production, i.e., costs per 1 ton. This indicator makes comparability possible.

In natural conditions we included "the ratio of drilling and blasting costs to production" and "average prices of individual assortment items". These prices reflect the quality of the aggregate.

In the technology area, we have included "ratio of machine cost to production" and "ratio of service cost to production".

In the area of quarry management, we have included "ratio of wage costs to production" and "ratio of total costs to production."

Again, the analysis was carried out separately for the deterioration of the economic result and separately for the improvement of the economic result.

Deterioration of the economic result: costs

Natural conditions: deterioration of the economic result occurred in 13 cases. Of which:

- in 7 cases, the ratio of drilling and blasting costs to production increased, and at the same time, in 7 cases, higher sales per 1 ton of production were achieved;
- in 6 cases, the ratio of drilling and blasting costs to production was reduced, and at the same time, in 4 cases, higher sales per 1 ton of production were achieved.

Technology: the economic result deteriorated in 13 cases. Of which:

- in 8 cases, the ratio of machinery costs to production increased, and at the same time, in 6 cases, the ratio of service costs to production increased;
- of these, in 2 cases, the stationary crusher was replaced by a mobile device, the operation of which was financed through the services;
- out of 8 cases of growth in the ratio of machine costs to production in 6 cases there was a decrease in production, i. e. a lower use of machines.

Quarry management: deterioration of the economic result occurred in 13 cases. Of which:

- in 10 cases there was an increase in the ratio of wage costs to production, at the same time there was a reduction in production volume in 8 cases. Increased wages were not linked to production bonuses;
- in 12 cases there was an increase in the ratio of total costs to production, at the same time in 9 cases the ratio of overhead costs to production increased.

Improving the economic result: costs

Natural conditions: the economic result improved in 17 cases. Of which:

- in 10 cases, the ratio of drilling and blasting costs to production increased, at the same time, in 8 cases, an increase in sales per 1 ton of production was achieved;
- in 7 cases, the ratio of drilling and blasting costs to production was reduced, at the same time, in 4 cases, sales per 1 ton of production were increased.

Technology: the economic result improved in 17 cases. Of which:

- in 12 cases, the ratio of machine costs to production decreased, and at the same time, in 11 cases, production increased. At the same time, in 7 cases, the ratio of service costs to production decreased.

Quarry management: the economic result improved in 17 cases. Of which:

- in 7 cases, there was an increase in the ratio of wage costs to production, and at the same time, in 4 cases, production increased;
- in 5 cases, the ratio of total costs per 1 ton of production increased, and at the same time, in 4 cases, the ratio of overhead costs per 1 ton of production increased.

Sub-summary for the costs: the increase in the ratio of drilling and blasting costs to production can be due to:

- by increasing the price of inputs for these activities;
- by switching to stronger, and thus superior quality parts of the deposit, which can be sold at higher prices.

However, if out of the 30 cases of analysed quarries there was an increase in sales per 1 ton of production in 77% of cases, this is rather a general increase in the price level of produced aggregates and not a transition to stronger parts of the deposit with the necessity of an increased number of boreholes and with higher unit consumption of explosives. An increase in sales per 1 ton of production also occurred at quarries, where the ratio of drilling and blasting costs per 1 ton of production fell.

The problem of the ratio of the costs of machines per 1 ton of production is linked with machine use – higher use means higher production and a decrease in the level of this indicator. Changes in technology in the form of reconstruction and replacement of stationary technology with mobile technology had a negative effect here, which increased the ratio of machine costs to production. Unsolved is apparently the issue of wages, which increase even in the situation of reduced production – in 65% of cases. The burden resulting from overheads also has a negative effect, where in 75% of cases the increase in the ratio of overhead costs to production is associated with an increase in total costs per 1 ton of production.

Overall Summary and Discussion

Deterioration of the economic result: out of 13 cases of deterioration of the economic result, there was an increase in

aggregate stocks in 11 cases and a decrease in sales revenue in 9 cases. Inventories of aggregate in stock are valued at cost-based prices, so quarries lose the profit mark-up when calculating the economic result. The deterioration of the economic result is therefore linked to sales problems.

At three quarries with a decrease in production, the stationary crushing line was changed to a mobile line, the operation of which was ensured as part of external services. In other cases, they were carried out reconstruction and modernization. In 9 quarries with a decline in production, the ratio of service costs to production increased. The reason was insufficient use of machines, which was caused by a decrease in production caused by sales problems. Of the 9 quarries with a decrease in production, in 8 cases the wage-to-production ratio increased. It points to the unresolved issue of labour management in connection with the interruption of mining in the winter period. The reduction in production was not in accordance with the development of significant variable costs – drilling and blasting, services, which led to an increase in the ratio of costs for these activities to production.

Sales problems associated with the decline in production, which was not matched by the development of variable costs, and demand for wages can be considered as the causes of the deterioration of the economic result.

Improving the of economic result: in 12 cases out of 17, i.e., in 70.6% of cases, both production and sales revenue increased. In 5 cases out of 17, i.e., in 29.4%, sales revenues decreased, but they were associated with a decrease in variable costs. This was mainly a decrease in the ratio of the costs of machinery to production in 70.6% of cases. This decrease in the ratio was due to a higher level of production, i.e., higher utilization of machines. In 41.2% of cases, the ratio of drilling and blasting costs to production decreased. The area of wage demand was problematic here as well. In 41.2% of cases there was an increase in the ratio of wage costs to production, but only in 23.5% of cases there was an increase in production. The motivating role of wages appears to be weak.

Conclusion

The analysis shows the importance of production, sales and costs planning. The economic result is, on the one hand, linked to sales revenue, which is influenced by the amount of production. It results in variable costs. From the point of view of sales, changes in the economic result are dependent on the share of production and assortment that the quarry has contractually guaranteed with customers. A higher share of guaranteed sales facilitates the planning of mining and variable costs.

A separate issue is the area of wages in the period when the climatic conditions do not allow activity in the quarry. It is solved by releasing workers for a limited time or creating reserves for winter activity. The growth of wage costs in the face of declining production does not indicate the motivational function of wages. From the point of view of overheads as fixed costs, the quarry is burdened with a share of costs that it cannot influence.

The idea of a successful company is usually associated with its high production. Quarrying, however, produces assortment items that hardly find a market – fine fractions. The economic results also depend on the distance to which the production is transported.

It can therefore be assumed that, despite the importance of the natural conditions of the deposit, changes in demand and management of variable costs are decisive for changes in the economic result.

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Zmiany w wynikach ekonomicznych kamieniołomów

Artykuł dotyczy analizy zmian wyników ekonomicznych 6 kamieniołomów w latach 2013-2018, czyli poprawy i pogorszenia wyników ekonomicznych. Analiza pokazuje, że na zmiany wyników ekonomicznych wpływają głównie zmiany w zarządzaniu sprzedażą i kosztami zmiennymi.

Słowa kluczowe: *kamieniołomy, wyniki finansowe kamieniołomów, zmiana wyników finansowych*